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Title of Proposed Observation:

Searching for Non-Maxwellian Distributions with COMP, EIS, and IRIS

Main Objective:

Diagnostics of the non-Maxwellian kappa-distributions and electron density from coordinated EUV/UV/visible observations

Scientific Justification:

We propose this HOP to acquire unique joint observations to probe the diagnostics for the non-Maxwellian distributions from Hinode/EIS, COMP, and IRIS. The target will be a limb active region and this will be a Target-of-Opportunity (ToO) HOP.

The assumption of a Maxwellian distribution is common in the analysis of solar spectra. However, this assumption may be incorrect if the emitting plasma is heated dynamically e.g. by nanoflares. A possible signature of such dynamic heating in the solar corona would be the presence of non-Maxwellian distributions.

The kappa-distributions, characterized by a high-energy tail, have been diagnosed in a transient coronal loop observations made by EIS in Fe XI—XII (Dudík et al. 2015, ApJ, 807, 123) and are also commonly observed in the solar wind (e.g. Maksimovic et al. 1997, Zouganelis 2008). Such distributions should result in an increase in the intensity of the coronal forbidden lines compared to the EUV ones (Dudík et al. 2014, A&A, 570, A124), an effect detectable by coordinated EIS, IRIS, and COMP ground-based coronagraphic observations. This is the focus of this proposal.

In order to disentangle the effect of kappa-distributions from the effects of the electron density and differential emission measure (DEM), observations of additional EUV lines are needed for density and DEM diagnostics. These additional lines can also be used for diagnostics of κ from EIS lines alone. The Fe XIII lines at 10747 and 10798 Å observed by COMP can also be used for independent diagnostics of electron density that can be compared with the densities from EIS Fe XIII lines.

The observations should be run during February, May-June, or August-September, when there is more than average probability (the average being 68%) of good weather conditions at the Mauna Loa Solar Observatory. This is a much higher chance than for the COMP-S instrument at Lomnický Peak Observatory (1 in 7) involved in the previous HOP 265 observations. For this HOP, use the CompS_NonMax sequences developed previously.

The proposers will examine data from SDO and STEREO-A to determine, ahead of an observing plan, whether the observations should go ahead, and at which position angle on the limb. Given this point in the solar cycle, however, we expect that there will be a limb active region for much of the period.

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SSC Point of Contact: EIS -- Len Culhane (UCL)

Dates: ToO

February, May-June, or August-September offer the best "coronagraphic" conditions at Mauna Loa Solar Observatory – sunny weather with good seeing – with a chance of more than 68%.

Repeating the observations for at least three consecutive days if possible is required to maximize the chance of best observing conditions.

Time window: 18:00 - 00:00 UT

Target(s) of interest: Off-limb active region containing coronal loops emitting in Fe IX-XIV.

SOT Requests:

No specific observations are requested due to the off-limb nature of these observations. We are happy to discuss what may be performed with the SOT team, however.

EIS Requests:

CompS_NonMax has 4 different variations: 120, 90, 60 and 30 (number indicates the slit exposures in seconds). Use the CompS_NonMax 60 and 120 studies specified by proposer. All variations use 2" slit to scan an 80"x512" off-limb region in 2" steps. We have opted to use DPCM compression.

Observations should be run in the following sequence:

CompS_NonMax_60

CompS_NonMax_120
PRY_slot_context_v3

Typically, the sequence should be repeated 3 times.
Pointing and study variation to be selected by J. Dudik (dudik@asu.cas.cz)

Typically, raster off-limb above AR core so that the innermost edge of the raster is 30" above the solar limb. The target for the AR Observations ***MUST*** be above the limb, otherwise COMP will not be able to observe it.

Depending on the size of the AR, the proposer may specify that several rasters are to be stitched together to cover a wider range in X, in which case, this will be indicated in the instructions.

Observations should be performed during 18 – 00 hr UT.

Repeating the observations for at least three consecutive days if possible is required to maximize the chance of best observing conditions. February, May-June, or August-September offer the best "coronagraphic" conditions at Mauna Loa – sunny weather with good seeing – with a chance of more than 68%.

Once the target selection has been communicated to the Hinode COs, and the Hinode pointing plan has been finalized, please send target specifications (position angle and heliocentric co-ordinates) to COMP observers before 12:00 UT on the observing day: tomczyk@ucar.edu

If bad observing conditions are forecast at Mauna Loa, the observers there will inform the Hinode Chief Observers that observations will not be required, in case there is time for Hinode to schedule other observations instead.

XRT Requests:

Due to the long-duration nature of the EIS exposures, it would be helpful to have observations from XRT on a cadence matching the EIS exposures, and a duration matching the EIS observations, primarily for alignment purposes. The cadence of XRT should therefore be between 60 and 120 seconds, in one or more filters.

IRIS Requests:

Observe the Fe XII 1349.4 Å line
126 x 170 arc sec raster with 2 arc sec steps, 60 s exposure time
-or- 95x170 arc sec raster with 1 arc sec steps, 60 s exposure time

Program 1:
3610195162 | Very large coarse 64-step raster 126x175 64s C II Si IV Mg II

h/k | 3929.89 | 230.73 | 0.1 | 61.4+/-0.1 | 3930+/-0 | 245.6+/-0.0 |
245.6+/-0.0 | 245.6+/-0.0 | 0.0+/-0.0

Program 2:

3610195167 | Very large sparse 96-step raster 95x175 96s C II Si IV Mg II
h/k | 5898.56 | 371.44 | 0.1 | 61.4+/-0.1 | 5899+/-0 | 184.3+/-0.0 |
184.3+/-0.0 | 184.3+/-0.0 | 0.0+/-0.0

spacecraft rolled at 90 degrees (if possible)
repeat during the entire EIS observation time
onboard binning of at least 4x2

Additional instrument coordination:

MLSO/COMP

Previous HOP information:

HOP 226 - Dudik et al. (2015), ApJ, 807, 123
HOP 265 - bachelor thesis of J. Lorincik (J. Dudik supervisor). Coordinated
observations with COMP-S not possible due to bad weather conditions at
Lomnický Peak Observatory (see Scientific justification).

Additional Remarks:

Request to COMP:

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Sun-centered observations in the Fe XIII IR doublet (both 10747 and 10798 Å lines) encompassing the EIS FOV are required, alternating regularly between 10747 and 10798 lines using at least 5 points using the '5point.dynamics' sequence (or more if possible) scanning across the line profiles during the whole observing time. Neighboring "continuum" needs to be observed as well in order to separate the line intensity from the K corona.

Polarization measurements are not required. The He I line at 10833 Å is also not required.

Other participating Instruments:

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SDO/AIA will offer context images for co-registration and additional information about the Fe XVIII upper limit (AIA 94A filter) for DEM modeling.